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09/918,115	07/30/2001	Michael Graetzel	16090-23	2594

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EXAMINER
HU, SHOUXIANG

ART UNIT	PAPER NUMBER
2811	15

DATE MAILED: 04/21/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application N .	Applicant(s)	
	09/918,115	GRAETZEL ET AL.	
	Examiner	Art Unit	
	Shouxiang Hu	2811	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Peri d f r Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *24 February 2003* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1 and 5-18* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☐ Claim(s) *1 and 5-18* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Pri rity under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Claim Objections

1. Claims 1 and 5-18 are objected to because of the following informalities and/or defects:

Throughout the claims, especially in claim 1, the terms of "electron conductor" and "hole conductor" should read as: –n-type semiconductor– and –p-type semiconductor–, respectively, because they are actually of semiconductors, instead of conductors, and also because either conductor or semiconductor can always conduct both electrons and holes therein in the sense that both electrons and holes can drift therein.

Appropriate correction is required.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> **The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.**

3. Claims 1 and 5-18 are rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Full support is not found in the original disclosure for the subject mater of "individual point-contact-type

heterojunctions between said quantum dots and said electron conductor and said hole conductor", as recited in newly amended claim 1. It is not clear how a p-n junction or junctions can be formed between the recited three elements (quantum dots, electron conductor and hole conductor), given the fact that a p-n junction is normally formed only between a p-type semiconductor and an n-type semiconductor.

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

5. Claims 1, 5-8, 13-15 and 17, insofar as being in compliance with 35 U.S.C. 112, are rejected under 35 U.S.C. 102(b) as being anticipated by Siebentritt et al. ("Siebentritt"; 14th European Photovoltaic Solar Energy Conference, Barcelona, Spain, 30 June-4 July 1997, pages 1823-1826; of Record).

Siebentritt discloses a solid state sensitized solar cell having a p-n heterojunction (Figs. 1 and 2); comprising: an electron conductor (an n-type semiconductor made of solid state TiO_2, with nanocrystalline and a large band gap); a hole conductor (a p-type semiconductor made of inorganic solid state CuI); a transparent first electrode (SnO_2:F); a second electrode ("metal"); and a CdS sensitizing semiconductor between the electron and hole conductors.

It is noted that the CdS sensitizing semiconductor in Siebentritt inherently comprises individual quantum-dot particles adsorbed at the surface of the electron conductor, because Siebentritt further discloses that the chemically deposited CdS sensitizing semiconductor permeates the finer structure of the porous TiO_2 structure (see section 3.3, on page 1826). Furthermore, it is noted that Siebentritt also discloses that the CdS sensitizing semiconductor is formed through the same method as described in Weller et al. (or, Vogel et al. ("Vogel"; Chemical Physics Letters, V174, N3&4, 9 November 1990, pages 241-246; of record)), with the number of the repeating times of the dipping process including a number as low as 20 (see the upper left column on page 1824 of Siebentritt). And, according to Vogel, the resulting CdS sensitizing semiconductor comprises individual particles of quantum dots, even with the dipping process being repeated to as high as 30 times (with the size of individual quantum-dot particles being up to 200 Angstroms; see the abstract, section 3, and Fig. 1D in Vogel). Therefore, the resulting CdS sensitizing semiconductor in Siebentritt inherently comprises individual particles of quantum dots adsorbed at the surface of the electron conductor. Thus, the solid state sensitized solar cell of Siebentritt inherently comprises individual point-contact p-n heterojunctions.

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the

invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

7. Claim 10 is rejected under 35 U.S.C. 103(a) as being obvious over Siebentritt et al. ("Siebentritt"; 14th European Photovoltaic Solar Energy Conference, Barcelona, Spain, 30 June-4 July 1997, pages 1823-1826; of Record) in view of Thelakkat et al. ("Thelakkat"; Synthetic-Metals (Switzerland), Vol. 102, No. 1-3, p. 1125-8, June 1999).

The disclosure of Siebentritt is discussed as applied to claims 1, 4-8, 13-15 and 17 above.

Although Siebentritt does not expressly disclose that the hole conductor can also be made of a polymer, one of ordinary skill in the art would readily recognize that a hole conductor can also be formed of a polymer, as evidenced in Thelakkat (see the hole conductive polymer TPD in Fig. 5); and that in general organic semiconductor materials tend to be mechanically flexible and tend to be made with a simplified process and reduced cost, compared with inorganic one.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to make the solar cell of Siebentritt with the hole conductor being made of a polymer, as taught in Thelakkat, so that a solar cell with improved flexibility, simplified process and/or reduced cost would be achieved.

8. Claims 9, 11 and 12 are rejected under 35 U.S.C. 103(a) as being obvious over Siebentritt et al. ("Siebentritt"; 14th European Photovoltaic Solar Energy Conference, Barcelona, Spain, 30 June-4 July 1997, pages 1823-1826; of Record) in view of Bach et al ("Bach"; Nature, V395, 8 October 1998, pages 583,585; of record).

The disclosure of Siebentritt is discussed as applied to claims 1, 4-8, 13-15 and 17 above.

Although Siebentritt does not expressly disclose that the hole conductor can also be made of an organic OMeTAD, one of ordinary skill in the art would readily recognize that organic OMeTAD is an art-recognized hole conductor for solar cells, as evidenced in Bach (see the abstract); and that in general organic semiconductor materials tend to be mechanically flexible and tend to be made with a simplified process and reduced cost, compared with inorganic one.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to make the solar cell of Siebentritt with the hole conductor being made of an organic OMeTAD, as taught in Bach, so that a solar cell with improved flexibility, simplified process and/or reduced cost would be achieved.

9. Claim 16, insofar as being in compliance with 35 U.S.C. 112, is rejected under 35 U.S.C. 103(a) as being obvious over Siebentritt et al. ("Siebentritt"; 14th European Photovoltaic Solar Energy Conference, Barcelona, Spain, 30 June-4 July 1997, pages 1823-1826; of Record) in view of Kay et al. ("Kay"; 5,525,440).

The disclosure of Siebentritt is discussed as applied to claims 1, 4-8, 13-15 and 17 above.

Although Siebentritt does not expressly disclose that the cell can further comprise a dense semiconductor layer between the first electrode and the heterojunction, Kay teaches to form a photo cell (Fig. 1) comprising a dense

semiconductor layer (3; a non-porous TiO_2) between a first electrode (2A) and the cell junction portion (4-6) for providing a desired diffusion barrier therebetween.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the dense semiconductor layer of Kay into the solid state sensitized photovoltaic cell of Siebentritt, so that a photovoltaic cell with a desired diffusion barrier would be obtained.

10. Claim 18, insofar as being in compliance with 35 U.S.C. 112, is rejected under 35 U.S.C. 103(a) as being obvious over Siebentritt et al. ("Siebentritt"; 14th European Photovoltaic Solar Energy Conference, Barcelona, Spain, 30 June-4 July 1997, pages 1823-1826; of Record) in view of Vogel et al. ("Vogel"; Chemical Physics Letters, V174, N3&4, 9 November 1990, pages 241-246; of record).

The disclosure of Siebentritt is discussed as applied to claims 1, 4-8, 13-15 and 17 above.

Although Siebentritt does not expressly disclose that the deposition treatment for the quantum dot particles can be performed 2-10 times, Vogel teaches that sensitizing particles with deposition treatment (dipping process) performed 5 or 10 times have very small size and lead to higher incident photon to current efficiency (IPCE), compared to the one with higher dipping-process repeating times (see Figs. 1-4).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to make the solar cell of Siebentritt with the deposition

treatment for the sensitizing particles being performed 5 or 10 times, per the teachings of Vogel, so that a solar cell with high IPCE would be achieved.

Response to Arguments

11. Applicant's arguments filed on January 13, 2003 have been fully considered but they are not persuasive.

Applicant's main arguments include: (A) The CdS material in Siebentritt is not in the form of individual quantum dot particles; and (B) It is not obvious to incorporate the teachings of Vogel into the solid state heterojunction of Siebentritt to obtain the claimed invention, because Siebentritt teaches away from Vogel.

In response to above Arguments A and B, as noted in the claim rejections set forth above in this office action, the CdS sensitizing semiconductor of Siebentritt inherently comprises individual CdS quantum dots particles adsorbed at the surface of the electron conductor, as Siebentritt discloses that the TiO_2 electron conductor has a structure with nanoporous (see section 1 on page 1823), and that in the solar cell (note: after the annealing at 125 ^{0}C; see the upper left column on page 1824) no element contrast can be found within the TiO_2/CdS layer (note: not layers), as the chemically deposited CdS sensitizing semiconductor has permeated the finer structure of the porous TiO_2 structure (see section 3.3, on page 1826). Moreover, Siebentritt also discloses that the CdS sensitizing semiconductor is formed through the same method as the one described in Weller et al. (or, Vogel), with the number of the repeating times of the dipping process including a number as low as 20. And, according to Vogel, CdS

sensitizing semiconductor formed with such a method inherently comprises individual quantum dot particles, even with the dipping process being repeated to as high as 30 times (see the existence of the individual quantum dot particles, up to 20 nm in size, in Fig. 1d of Vogel; also see the first two paragraphs in the section of "Results and discussion"). Therefore, the resulting CdS sensitizing semiconductor in Siebentritt inherently comprises individual quantum-dot particles.

Furthermore, it is noted that even through the CdS sensitizing semiconductor in Siebentritt may also comprise some non-quantum-dot-sized clusters, the very existing individual quantum-dot particles in Siebentritt are still readable as the individual quantum-dot particles as recited in claim 1 of the instant invention, because claim 1 is in an open-ended claim structure, which utilizes the term of "comprising" and thus does not necessarily exclude the existence of the non-quantum-dot-sized clusters in the other portion of the CdS semiconductor.

Moreover, with respect to Argument B, it is noted that one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.,* 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). In this case, the solar cell in Siebentritt is a solid state one that inherently comprises solid state quantum-dot-sized sensitizing particles adsorbed on the surface of the electron conductor. And, Siebentritt further teaches to incorporated the sensitizing-particles-forming method of Vogel into the solid state solar cell to form the CdS sensitizing material permeating the finer structure of the porous TiO_2. Vogel is further cited in the

above claim(s) rejection for showing that one of ordinary skill in the art would readily recognize the desirable dipping-process with 5 or 10 repetitions for forming finer particle size and achieving better IPCE, regardless what a film's reasonable thickness should be. Since Vogel effectively teaches that the number of repetitions is a resulted-oriented variable of importance, which would be then subject to routing experimentation and optimization. And, one of ordinary skill in the art would be readily motivated by Vogel to reduce the number of repetitions in the making of the solid state solar cell of Siebentritt, in order to achieve a solar cell with always-desirable high IPCE.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Shouxiang Hu whose telephone number is (703) 306-5729. The examiner can normally be reached on Monday through Thursday, 7:30 AM to 6:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tom Thomas can be reached on (703) 308-2772. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 872-9318 for regular communications and (703) 872-9319 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

SH
April 17, 2003

Shouxiang Hu
Patent Examiner
TC2800